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K-D-1894

ORGDP CONTAINER TEST AND DEVELOPMENT PROGRAM
FIRE TESTS OF UF_6-FILLED CYLINDERS

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ORGDP CONTAINER TEST AND DEVELOPMENT PROGRAM
FIRE TESTS OF UF_6-FILLED CYLINDERS

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ORGDP CONTAINER TEST AND DEVELOPMENT PROGRAM
FIRE TESTS OF UF_6-FILLED CYLINDERS

INTRODUCTION

Fire tests of bare, UF_6-filled shipping cylinders were conducted at the ORGDP Rifle Range during October 1965 as part of the AEC-ORO Container Test and Development Program presently under way at the ORGDP. The multipurpose effort was to determine if the cylinders would hydrostatically or explosively rupture; the time available for fire fighting before either incident occurred; and the degree of contamination as related to the type of UF_6 release, wind velocity, and terrain.

In addition to the cylinder fire tests, other tests were made for further evaluation of the fire-resistant BOX foam plastic. These included a newly designed shipping drum for 5-in.-diam cylinders, and 15B-type wood shipping boxes for small containers. In one case, the latter contained a UF_6-filled Harshaw cylinder. The test times ranged from 45 to 95 min. In no instance did temperatures exceed 200°F. These tests are discussed under Part B.

Our Nuclear Engineering Department was responsible for site preparation and the test program. The Safety and Health Physics Department, Mr. A. F. Becher, head, provided primary assistance in the conductance of the tests and was additionally responsible for the environmental monitoring and sampling. Personnel of the Plant Shift Operations and Security, Fabrication and Maintenance, and Technical Divisions provided further support in the various operations. Mr. J. E. Wescott of the AEC-ORO and Mr. J. W. Edwards, ORGDP, were in charge of the motion and still photography.

SUMMARY

Two each of the following types of cylinders were tested: 3.5 in. diam x 7.5 in. Monel Harshaw, 5.0 in. diam x 30 in. Monel, and 8 in. diam x 48 in. nickel. Fill limits were 5, 55, and 250 lb of UF_6, respectively, at an enrichment level of 0.22%. The larger cylinders were tested individually, with and without their metal valve covers. In the case of the small Harshaw cylinders and the uncapped 5-in.-diam cylinder, UF_6 releases occurred as a result of valve failure; the remaining cylinders ruptured explosively in a time interval of 8.5 to 11.0 min. The general type of test and results obtained are shown in the photographs in Appendix A.

6

610 # UF_6 0.22%

TEST FACILITY

Location

The ORGDP Rifle Range was selected as the most suitable test location based on the topography, normal wind direction for the fall period, distances to various plant facilities and public roads, availability of water for fire fighting, roads for equipment movement, and viewing areas. See map of test area (Fig. 1).

Equipment

Equipment for the fire test facility and the viewing station was constructed and installed within one week. The equipment consisted of the following:

1. Two concentric open-top tanks, 8 1/2 and 10 1/2 ft in diameter and 30 in. deep, welded to a 1/4-in.-thick, square base plate. The unit was positioned in a 1-ft-deep excavation. Test units were mounted on the center tank. Diesel oil was used as the fuel in both tanks, with the oil in the outer tank at a higher level to provide better temperature control.

2. A 15-ft-wide barricade of railroad rails and heavy steel grating, welded to inclined rail supports, was positioned adjacent to the tanks on the north side. A smaller barricade to prevent possible hot fragments from entering the nearby woods was positioned about 15 ft east of the tanks. Three-eighths-in.-thick steel panels, welded to framework mounted on steel skids, were used to protect the temperature recorders and the power supply generator.

3. A stainless steel frame for cylinder support was positioned in the center tank. A 3-ft-high ladder of stainless steel rods, with crossbars at 1-ft intervals and a thermal element at the center of each crossbar, was used to measure flame temperatures. Surface temperatures of the containers were also measured.

4. A roofed viewing stand was installed on a slight elevation about 200 ft north of the test location. It was constructed of railroad rail sections to which were welded 1/4-in.-thick steel panels. View ports were 1/2 by 6 in. long, at staggered heights, and larger openings with sliding doors and camera mounts were provided in one section for the photographers. The supports for the viewing stand and the site barricades were imbedded in concrete in 4 1/2-ft-deep holes.

5. An adjacent brook was partially dammed to provide a water supply for control of the oil level in the tanks and for wet down of the adjacent area for grass fire control. A portable pump and a hose line were utilized for this purpose as well as for emptying the tanks. A sump pit was constructed for the oil and water removed from the tanks.

Other

A manned fire pumper was available to extinguish the oil fire on completion of each test, although the foam method of control was later used, and for

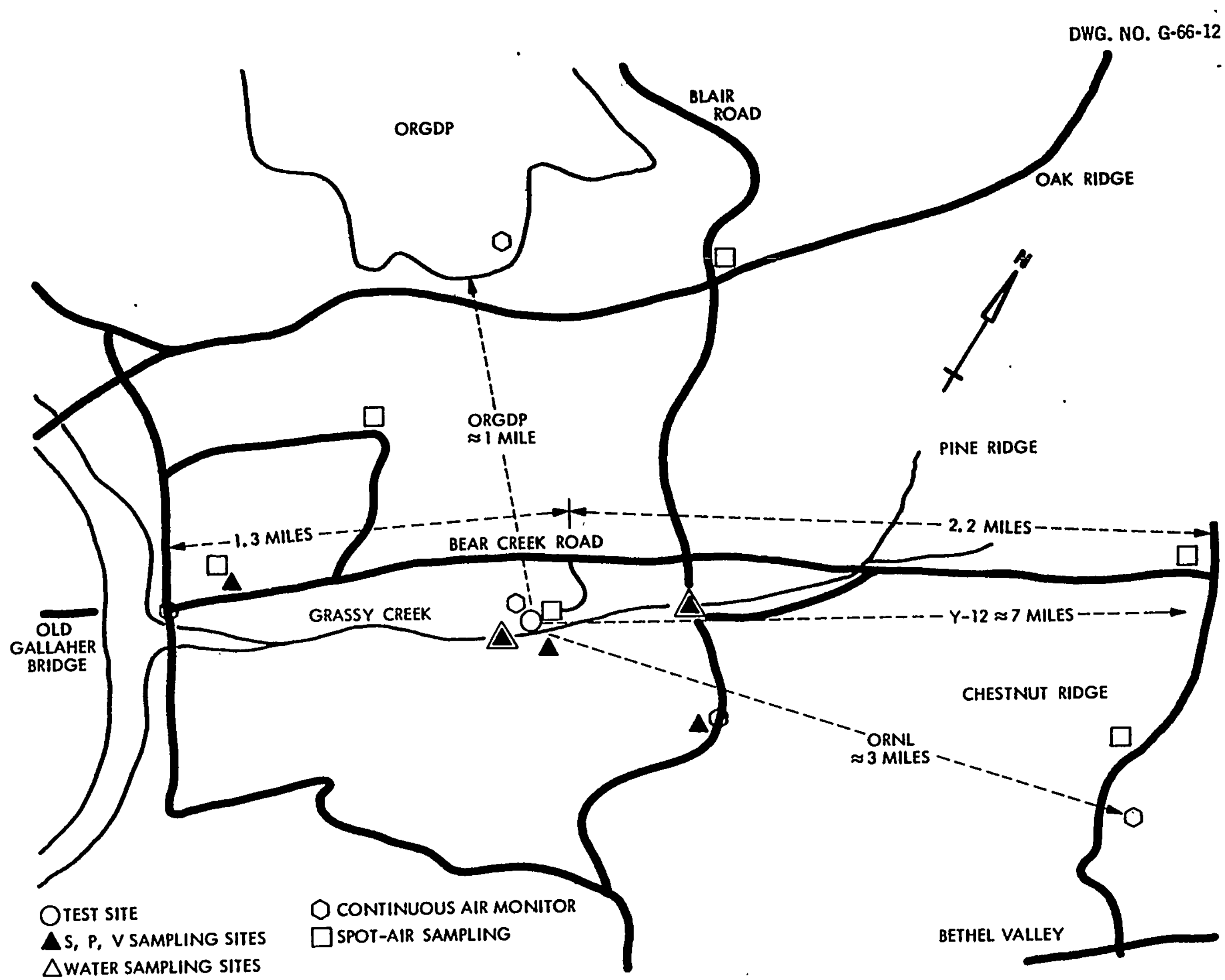

Figure 1
UF_6 CYLINDER - FIRE TEST SITE

possible grass fire and contamination control. Gas masks and safety helmets were furnished to test personnel, and radio communication was available between all test area locations and plant facilities.

An air monitor equipped with a wind direction vane and velocity recorder was positioned at the site, and others were at specific locations within a mile radius. A portable unit mounted in a truck was also used to monitor at various road locations in event of wind direction changes. Sites for soil, grass, and pine needle contamination sampling were selected prior to the tests. Test data for these locations are given in Appendix B.

GENERAL PROCEDURE

The ORNL Forestry Branch was notified 24 hrs or more in advance of the tests to assure that personnel on special projects or engaged in wood-cutting operations would not be within the test site area. Our Fabrication and Maintenance Division assumed the same responsibility for road and line crews. The AEC patrol was also notified in advance, and they provided roadblocks at the intersection of Bear Creek and White Wing Roads and at the old Gallaher Bridge entrance to the Bear Creek Road. No one was allowed to enter the area within 15 min of test time.

Close liaison was maintained with the AEC-ORO Biology Branch of the Research and Development Division and the Safety Branch of the Engineering Division, members of which witnessed the tests. Only a limited number of personnel were permitted at the adjacent view site; other visitors and personnel assisting were at sites 800 to 900 ft distant.

TEST PROGRAM

A. UF_6 Cylinders

Test I

Type of Cylinder: 3 1/2 in. diam x 7 1/2 in. Monel Harshaw

Date: Monday, October 4, 1965

Cylinder Fill Weight: 5 lb - UF_6

Wind Direction and Velocity: Southwest - 4 to 7 mph

Start: 10:52 a.m.

End: 10:58 a.m.

Result: UF_6 Release - Valve Failure

Two cylinders were tested. One had a plastic seat and a threaded stem section, the other a metal seat and a nonthreaded stem section. They were strapped to the stainless steel support frame in the inner tank, and the stainless steel ladder with thermal elements positioned at 1-ft intervals was used to measure fire temperatures. In this and in other tests, the oil level was initially 10 in. below the cylinder.

The mean fire temperature at the cylinder level was slightly over 1500°F, with temperatures ranging to 1700°F. The plastic seat valve failed in about 4 min. Later examination indicated that the Teflon seals on the stem had melted, and the threaded section holding the stem had enlarged, permitting UF_6 leakage. The gas pressure generated due to the heat then blew the threaded valve bonnet off, allowing the UF_6 to escape to the atmosphere. The second valve failed in about 6 min as the silver solder joint melted, and the valve stem assembly was blown from the unit. Small UF_6 clouds were noted at the time of each release, but complete dispersion by the heat occurred. No contamination was recorded by the air monitors, shoe monitoring, or ground checks.

Test II

Type of Cylinder: 5 in. x 30 in. Monel with Valve Cover

Date: Tuesday, October 5, 1965

Cylinder Fill Weight: 55 lb - UF_6

Wind Direction and Velocity: Southwest - <5 mph

Start: 11:00 a.m.

End: 11:10 a.m.

Result: Cylinder Ruptured Explosively

The 5-in.-diam cylinder was fastened to the SS support frame in the inner tank by a cable across each end, with the cables clamped to the tank wall, and by metal straps fastened to the frame. Thermocouples attached to the previously tested and valveless Harshaw cylinders were used to monitor temperatures; no thermoelements were fastened to the 5-in.-diam cylinders. Flame temperatures were assumed to be at least 1500°F.

Five minutes after the start of the test a small explosion was heard, but no UF_6 release was noted. At the end of 10 min, a violent explosion occurred, followed by a large, intense fire of yellowish white and orange coloration. This dissipated shortly. A mushroom cloud effect, typical of large explosions, was noted at a height of about 150 ft. The recorded wall temperature of the empty Harshaw cylinder at the time of the explosion was 1460°F. The fire was extinguished, utilizing the fire pumper and a fog nozzle.

The SS reinforced frame on which the cylinder was mounted was almost completely demolished. The cylinder head was blown about 57 ft in a direct line from the original position; it had sheared cleanly just below the steel ring to which cylinder handles are fastened. There was a 2-in.-long crack in the rim edge of the valve cap. This accounted for the first explosion and was probably caused by UF_6 gas pressure, resulting from valve leakage and the high temperature. The cylinder and connecting base section were found in the tank as flat sheets of metal. Most of the oil and water had been blown from the inner tank. The large fireball formed may be attributed to the vaporization of these items plus their chemical reaction with the UF_6.

Airborne contamination noted at all monitoring stations was barely above background. There was no contamination noted for the local ground area or on shoes or clothing; the particle sizes of uranium compounds formed were apparently so small that they were dispersed over a wide area in the downwind direction.

Test III

Type of Cylinder: 8 in. I.D. x 48 in. Nickel with Valve Cover

Date: Thursday, October 7, 1965

Cylinder Fill Weight: 248.9 lb - UF_6

Wind Direction and Velocity: Southeast - 8 to 12 mph

Start: 3:03 p.m.

End: 3:13 1/2 p.m.

Result: Cylinder Ruptured Explosively

Since the 5-in.-diam cylinder explosion had destroyed the SS support rack previously used, the 8-in.-diam cylinder was supported by two sections of railroad rails placed across the tanks at right angles to the cylinder. The cylinder was fastened to the rails by metal straps and to both the rails and tank by two cables, one across each end of the cylinder. This method was employed in subsequent cylinder tests. There were no temperature data obtained since it was assumed that the fire temperatures would be 1500°F or greater.

The cylinder explosion was not quite as sharp as when the 5-in.-diam cylinder exploded; this was probably due to the difference in hydrostatic rupture test levels, 2450 psi vs 8250 psi. However, the fire conditions after the explosion were essentially the same, with flames streaming an estimated 75 to 100 ft into the air. Photographs 2 and 3 in Appendix A were taken by Mr. James A. Sisler at a distance of 800 ft. They show the fireball at or near its maximum and the cloud formation which occurred shortly afterward. Later survey measurements of field distances and elevations, based on these pictures, indicated the fire area shown to be about 78 ft across and 75 ft high. Despite the relatively high wind, the fire in the tanks was extinguished in less than 3 min, utilizing high expansion foam equipment which produces foam at an expansion ratio of 1000:1. This procedure was used in the remaining tests.

A section of the cylinder, about 2 ft square, was found in the adjacent brook at a distance of about 50 ft from the tanks and at an angle of about 20° from the original position. The remaining body section, a flat metal sheet, and the end section were in the tank. The cylinder fill tube was discovered about 200 yards distant, in a straight line direction. The cylinder head containing the valves and valve cap has not been located despite intensive searches. These included mowing large areas of the site, removal of brush areas, and check of the brook and its banks.

Contamination results were again minimal. Although wind direction was toward ORNL, no readings above background were reported by the concerned agencies at that location.

Test IV

Type of Cylinder: 5 in. diam x 30 in. Monel without Valve Cover

Date: Thursday, October 14, 1965

Cylinder Fill Weight: 53.04 lb - UF_6

Wind Direction and Velocity: Southwest - 1 to 2 mph

Start: 11:24 a.m.

End: 11:34 a.m.

Result: Valve Failure and UF_6 Release

This cylinder contained a 1/2-in.-I.D. Monel thermowell positioned between the valves and extending nearly to the bottom of the cylinder. TE's were inserted in the well, near the top and bottom, and held in position against the wall with packed insulation. Two TE's were fastened externally to the cylinder by clamping pads in approximately the same locations. However, connecting wires in both top positions were broken, and no data were obtained from these points. A 70-ft-long line, containing two small traps of steel wool and activated alumina, was positioned to secure gas samples of reaction products. Suction was supplied by the aspirator effect obtained through connecting the discharge of a pump to the line.

A small UF_6 release was observed at the valve end of the cylinder at the end of 8 min; one minute later, both valves appeared to be releasing full streams. When the release appeared to be over at the end of 10 min, a single stream of UF_6 shot out of the cylinder for a distance of 6 to 8 ft.

Examination of the cylinder revealed one valve had completely eroded on one side and the valve cap and stem were missing. The other valve had released for a while but had then become plugged with UF_4 and melted metal. The stem of this valve was still in place, but the Teflon packing had melted, and the threaded section holding the stem apparently had expanded sufficiently to permit leakage. The cylinder was also found to be expanded almost 1/2 in. in circumference near the weld attaching the base to the cylinder body section.

The thermal element at the lower end of the thermowell recorded a straight line temperature increase to 1800°F. This was followed by a slight variation, then by a sharp jump to 2000°F, and an immediate decrease back to the 1800°F level. Further cooling occurred as the fire was extinguished. The high temperature may have been due to the exothermic heat from the reaction of the UF_6 at the valve area which primarily affected the thermowell wall; the temperature increased sharply as the UF_6 content escaped. The external thermal element registered a small dip in the temperature climb, from 675 to 640°F, about 3 min after the start of the test. The temperature then increased in a straight line to about 1700°F where, after similar variation, it reached 1780°F. This may have been due either to the radiant heat from the sudden temperature rise of the thermowell or to the interval of continued heating of the empty cylinder before the fire could be extinguished. The gas sampling results were only partially successful. The steel-wool trap contained 0.44 mg of uranium, the alumina trap 8.50 mg. Valence of the material could not be determined. Since it was readily washed from the pipes, it was considered to be UO_2F_2. Smear tests inside the pipe indicated no residual compounds.

Test V

Type of Cylinder: 8 in. I.D. x 48 in. Nickel without Valve Cover

Date: Friday, October 29, 1965

Cylinder Fill Limit: 245 lb - UF_6

Wind Direction and Velocity: Southwest - 3 to 5 mph

Start: 1:50 p.m.

End: 1:58 1/2 p.m.

Result: Cylinder Ruptured Explosively

In an effort to secure additional cylinder internal temperature data, two 1/2-in.-I.D. x 40-in.-long Monel thermowells were installed in the base of the unit. One well was positioned slightly off center, the second was bent so that, for several inches, it was about 1/4 in. from the cylinder wall before curving back into the unfilled part of the cylinder (Fig. 2). A TE in the bent section of the thermowell was on the down side of the cylinder when in test position. A second TE was at the 40-in. limit. In the straight line well, the thermal elements were in approximately the same positions with respect to internal distances from the base. Additional TE's were clamped in position externally, near each end of the cylinder.

The method of gas sampling previously tried was again used except the collector traps were not installed, and the open end of the pipe was positioned about 4 ft above the cylinder center. It was considered that the products collected would condense in the long line due to the pressure-temperature differential. However, only 0.28 g of uranium was found in the pipe section extending over the cylinder, 0.06 g in the adjoining section, and 0.01 g in the 40-ft length of copper tubing.

The cylinder ruptured explosively in 8 1/2 min without release from the valves. On the basis of previous cylinder hydrostatic tests, this result had appeared quite possible. The explosion was about the same intensity as that for the 8-in. cylinder with valve cap, but the resulting fireball did not appear to be as large. A green coloration of the flames near the center of the cylinder was observed prior to the explosion, indicating a possible UF_6 release and nickel compound formation. Both steel rails were blown from the tank; the east rail, with the lower half of the cylinder still attached, was blown about 4 ft from the outer tank. The cylinder head was found about 52 ft from the tank; the upper section of the cylinder body, altered to a flat sheet of metal, was in the inner tank. Again, most of the unburned oil and the water were blown from the inner tank. Inspection of the cylinder head indicated the valves were apparently undamaged by the fire. This was verified later when the valves were removed, bisected longitudinally, and the threaded stem and metal seat were found in good condition although the Teflon stem gasket had melted. The silver solder sealer, where the valves were threaded into the cylinder end cap, was not melted.

Some ground contamination was visible between the test site and the recorders, about 40 ft distant. This was washed away with the auxiliary hose system. Although high-speed gears were installed in the temperature recorders, the temperature readings obtained do not permit an accurate assessment of what occurred internally in the heating interval. In this instance, the maximum internal temperature, 430°F, was recorded by the top thermal element in the non-UF_6 zone. The thermal element in the thermowell within a quarter inch of the wall

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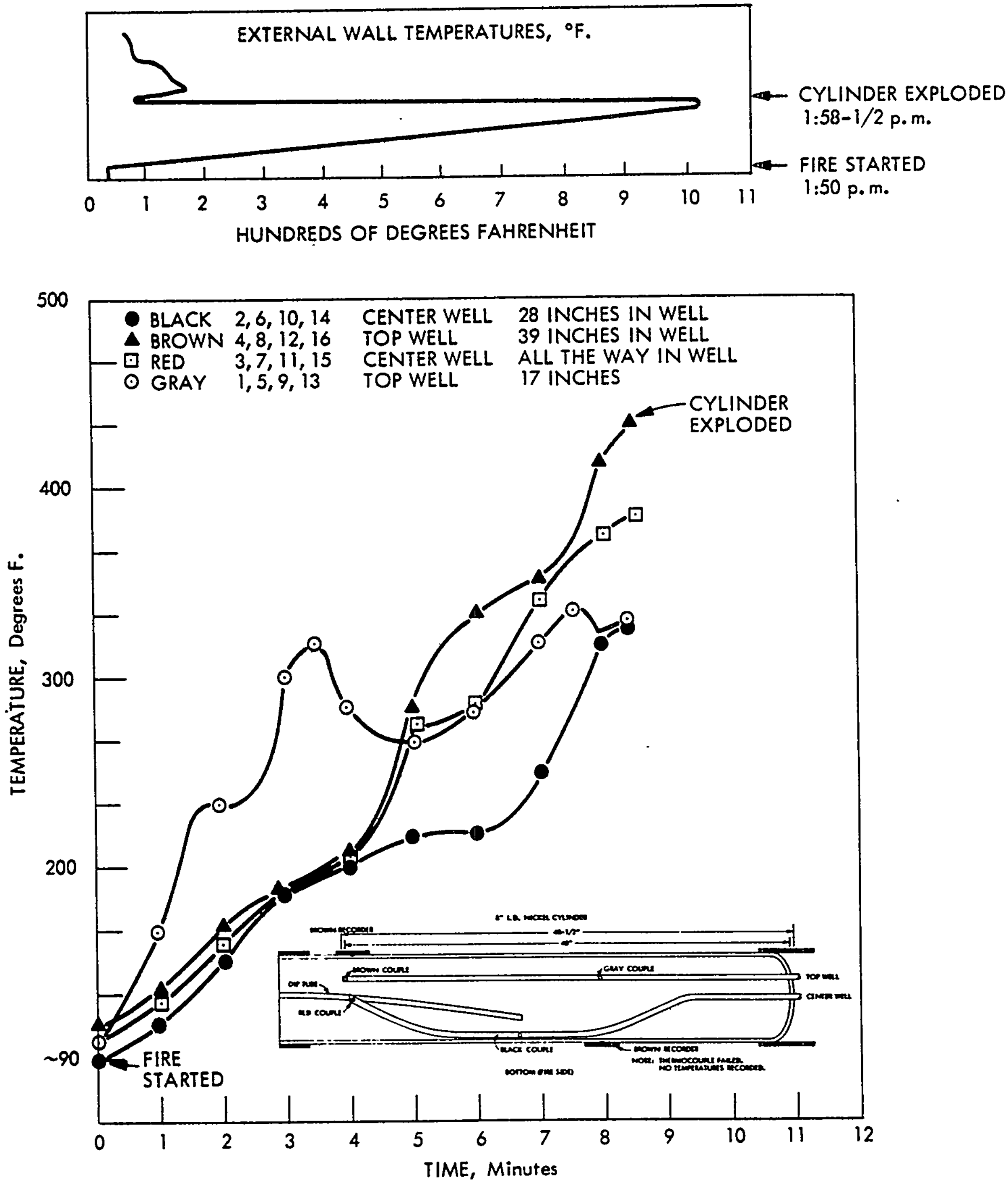


Figure 2
8" DIA. NICKEL CYLINDER FIRE TEST, 10-29-65

zone and the one in the center well registered about the same temperature (330°F) at the time of the explosion. However, considerable variation in temperatures recorded occurred; the temperature dips noted in previous tests were again apparent (Fig. 2).

Conclusions

The fire tests were highly useful. They confirmed that UF_6 cylinder rupture of explosive force is possible and that it can occur within a time sufficiently short as to possibly preclude fire fighting unless initiated very promptly. The explosions noted cannot be considered any more severe or hazardous than those due to other chemical or gas explosions. The amount of water blown from the tank by the force of the explosion contributed largely to the fireball formation, a cause which, in most transportation accidents, is unlikely to be so available.

The health physics air monitoring, soil, vegetation, and water data indicate that the UF_6 and the reaction products formed were so dispersed by the heat from the resultant explosion and fire that continuous tolerance levels were exceeded occasionally but only at a few monitoring locations, and these for brief intervals. Wind velocity, directional shifts, and the degree of fire largely determine the contamination pattern and extent.

In these tests, the combination of explosive force and heat from the fire dispersed the UF_6 and reaction products, and they were airborne to the extent that fallout contamination was only slightly above background in some instances and within limits in all cases. In the event combating of the fire, including cooling of the cylinders, cannot be initiated promptly and successfully, personnel in adjacent downwind areas should be quickly evacuated. This is the same precaution as would be employed in any chemical release.

The 120 to 130 gal of diesel oil contained in the inner tank on each test approximated that carried by tractor-trailer units. It is questionable that a large fire after a cylinder explosion could normally occur due to the oil or gasoline volume, fire exposure area, and probable lack of water for exothermic chemical reactions. However, fragments from an explosion could severely damage other cylinders and release additional UF_6. The monetary value of this material considerably exceeds that of other chemical materials transported.

Fire tests of the 12-in.-diam nickel MD cylinder or the 30-in.-diam steel cylinder are not considered necessary since it may be reasonably assumed that they would also rupture explosively. It appears desirable that additional information be obtained on temperature gradients, pressures, and material state in heated UF_6-filled cylinders. This could probably be done on a laboratory scale. Data obtained from such scale model tests would also be useful in establishing more accurate calculation methods.

B. BOX Foam Insulated Units

In the interval in which the series of UF_6 cylinder fire tests was in progress, various tests were also conducted of the BOX foam plastic as a fire- and heat-resistant packaging material for UF_6 shipments. The same equipment was used; the maximum times ranged from 45 to 95 min, and no container temperature exceeded 200°F.

Test I

The fire test, conducted on September 29, was of an improved method of shipping in which a 5-in.-diam x 30-in. UF_6 cylinder was positioned in a steel housing in an extended 55-gal drum. The space between the housing and drum, on all sides, was filled with several inches of the "foamed in place" BOX foam plastic. The drum containing the simulated UF_6-filled cylinder was heated for 45 min in a diesel oil fire ranging from 1450 to 1650°F, and then allowed to cool slowly. The highest temperature measured by the pellet-type temperature indicators used was less than 180°F. The indicators were positioned on the lid of the inner housing, on the housing wall, and at several positions on the cylinder.

Test II

The second test involved two type 15B wood shipping boxes for small UF_6 containers. One box had an empty Harshaw cylinder packed in polyurethane; the second box contained a UF_6-filled Harshaw cylinder packed in 4 1/2 in. of BOX foam. The test was conducted on October 4. The first box rapidly burned, leaving the empty cylinder. The wood structure of the second box also burned rapidly, leaving the BOX foam plastic. After 45 min of test time, the fire was extinguished and the plastic unit allowed to air cool. When the unit was cut open for inspection, charring was evident to a depth of 1 3/4 to 2 in. Temperatures of the UF_6 cylinders, as measured by pellet indicators, were less than 180°F; cylinder appearance was the same as when positioned in the box.

Test III

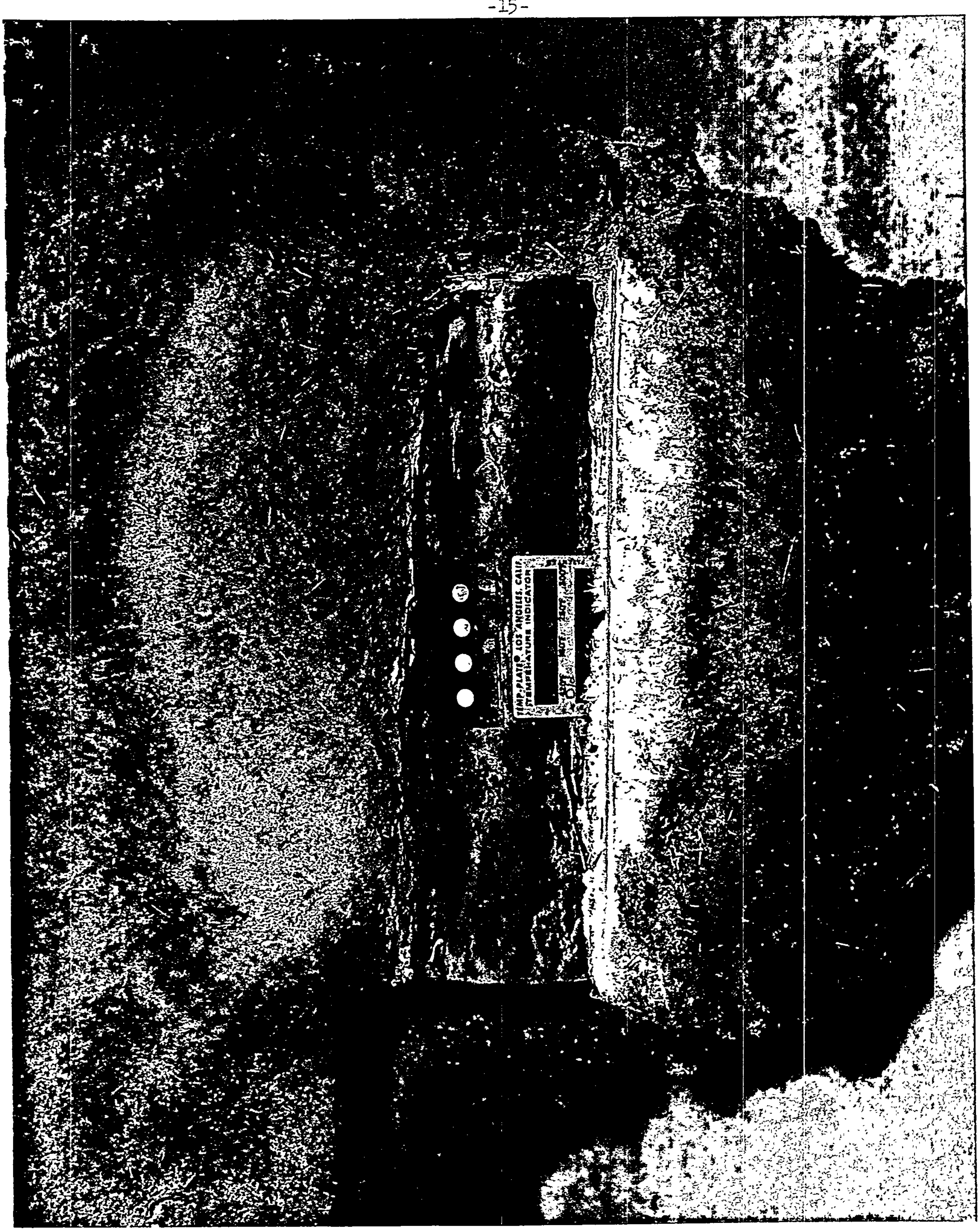
This test was conducted using two type 15B wood shipping boxes with a solid steel cylinder, 2 1/2 in. in diam x 18 in. long, centrally embedded in the BOX foam plastic in each box. These boxes were designed to provide 6 in. of plastic on all sides of the cylinder. They were positioned on railroad rails over the inner tank of the test system and were first fire tested for 45 min. The wind, originally 1 to 3 mph, increased to 10 to 12 mph during the test. After a cool-down period, additional oil was added to the tanks, the box positions reversed, and the rails realigned to permit better fire distribution on the boxes. This second fire test lasted 50 min, making a total fire test time of 95 min at temperatures ranging from 1400 to 1700°F.

After destruction of the wood enclosures, the plastic units were reduced about one-third from their original dimensions due to the fire and wind. They had also cracked and, judging by appearance, were considered to have failed the test. Shortly after removal from the fire, the units were cut open and both were found to have about 1 1/2 to 3 in. of original plastic still surrounding the cylinders. The maximum temperature for one cylinder, as measured by pellet indicators, was between 180 and 200°F; that for the second cylinder did not exceed 180°F. A special instrument check of the latter indicated the temperature was actually 159°F.

Conclusion

The BOX foam is considered to provide a high degree of fire protection for shipments of UF_6, provided thicknesses of foam in the order of 4 1/2 to 6.0 in. are used. In previous tests, it has also satisfactorily withstood the effects of the 30-ft drop test, based on 5-in. cylinder drum tests.

In connection with the development work, it may be noted that construction of a redesigned drum container for a 5-in. cylinder, which will permit better loading and unloading and probable multiple use, is in progress. It will be tested with a filled UF_6 cylinder in position in accord with the criteria for hypothetical accident conditions. A fire-resistant shipping container for the 30-in.-diam cylinder has also been designed and is under construction. It will undergo a similar test program.



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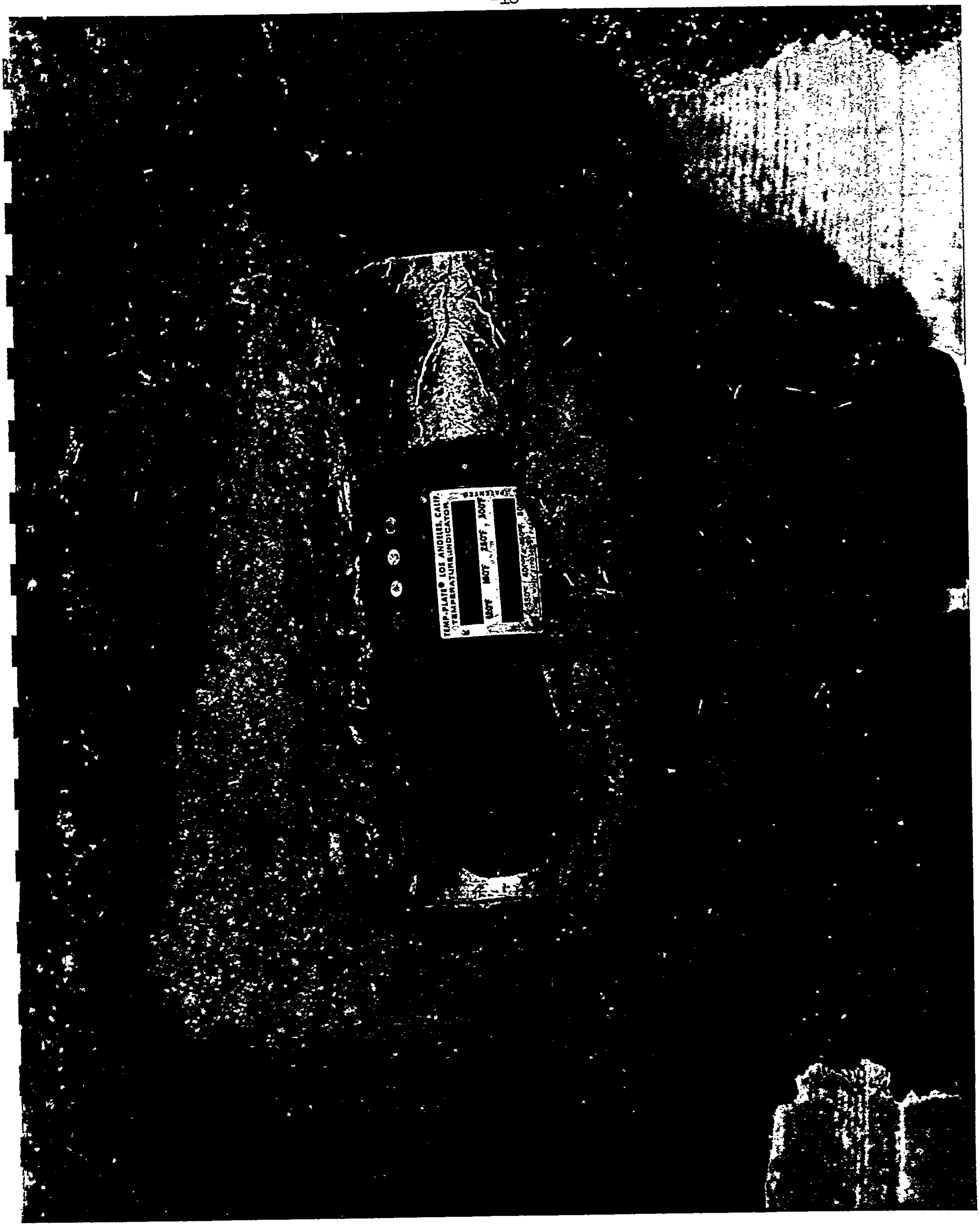

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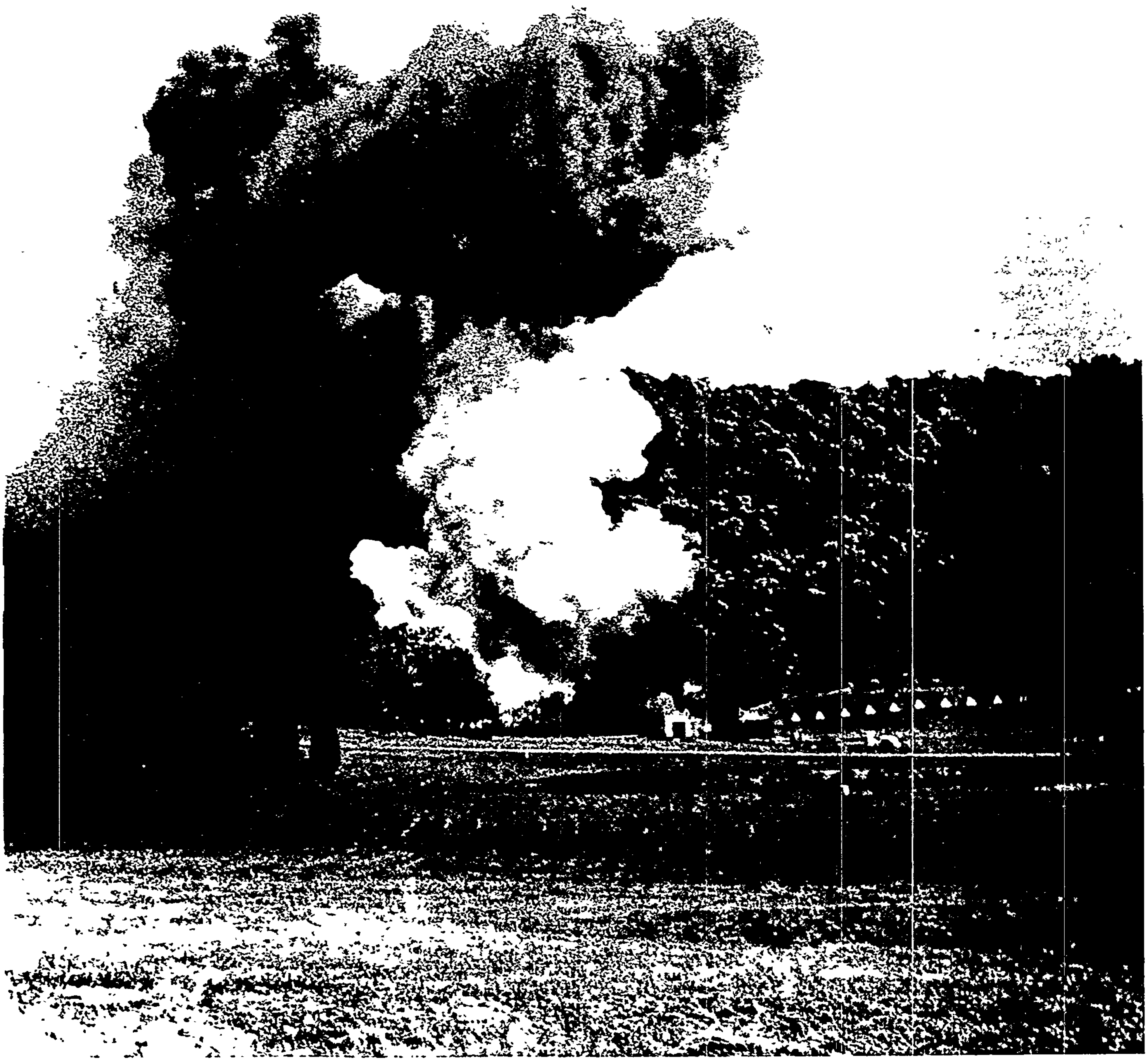
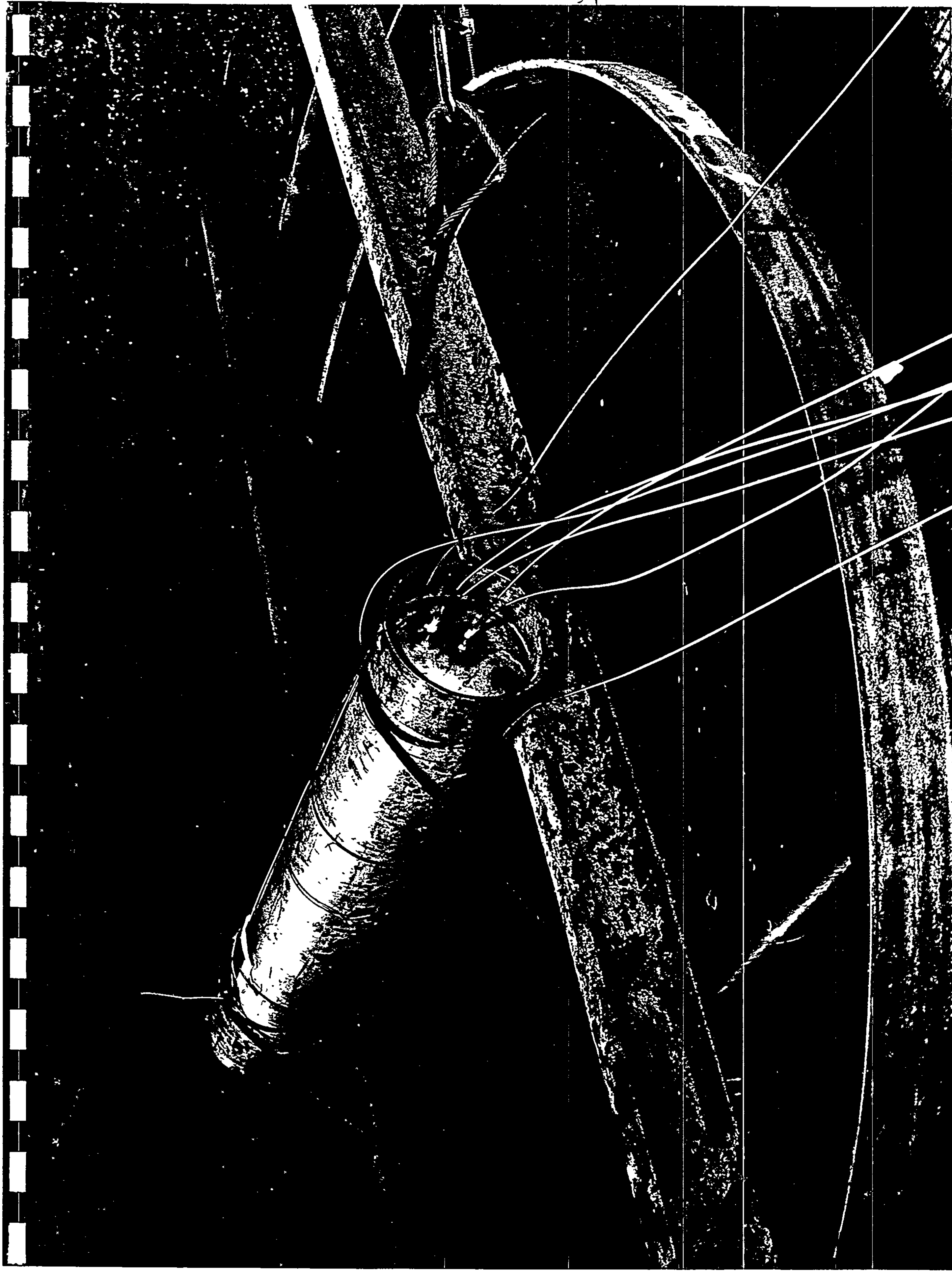
APPENDIX A

FIRE TESTS OF UF_6-FILLED CYLINDERS

1. Fire test in progress.
*2. Explosion and fire, 8-in.-diam cylinder with valve cover.
*3. Cloud effect shortly after explosion.
4. Instrumentation, 8-in.-diam cylinder without valve cover.
5. Explosion and fire, 8-in.-diam cylinder without valve cover. This view was taken immediately after the explosion. Fire area is not at full size.

*Photographs taken by Mr. James A. Sisler, Division of Transportation, AEC, Washington.





APPENDIX B

HEALTH PHYSICS DATA

UF$_6$ Cylinder Fire Tests

Environmental Sampling

Sample		Uranium (ppm)					
		9/20/65 Bkgd	10/4/65 +10#UF$_6$	10/5/65 +55#UF$_6$	10/8/65 +250#UF$_6$	10/14/65 +55#UF$_6$	11/1/65 +250#UF$_6$
Water Treatment Plant (≈1 mile WSW)	Soil	1.1	0.6	0.6	0.9	0.7	0.9
	Pine needles	0.1	0.1	0.1	0.1	0.0	0.0
	Veg. (grass)	[illegible].1	0.1	0.2	0.0	0.1	0.0
Rifle Range Border (East End)	Soil	1.8	2.2	1.1	0.6	2.9	2.3
	Veg. (grass)	0.1	0.1	0.1	0.1	0.1	0.0
Grassy Creek (Downstream) (100 ft SW)	Soil	0.8	1.0	0.9	2.0	1.8	5.7
	Veg. (grass)	0.1	0.1	0.1	0.2	0.1	0.1
	Water	-	0.002	0.013	0.054	0.046*	0.056
Grassy Creek (Upstream) (1000 ft NE)	Soil	0.1	1.4	1.2	1.2	0.6	1.1
	Veg. (grass)	0.0	0.1	0.1	1.8	0.0	0.0
	Pine needles	0.1	0.1	0.1	0.1	0.0	0.0
	Water	0.0	0.004	0.0	0.0	0.0	0.0
Chestnut Ridge (3000 ft East)	Soil	1.0	0.8	1.1	0.9	0.6	1.4
	Veg. (grass)	0.0	0.2	0.2	2.0	0.0	0.0
	Pine needles	0.1	0.2	0.1	0.1	0.0	0.1
Fire Tank Liquid	Water & Oil	-	-	28	142	72	1,640 356

*Resampled on October 26, 1965, following two days of rain: 0.002.

UF$_6$ Cylinder Fire Tests
Airborne Alpha Activity

Date	Test	Sample Location	Sample Period	U Alpha c/m/ft^3	*
10/4/65	10#UF$_6$ ≈11 a.m.	Test Site	10:15 - 11:15	0.303	CAM
		Test Site	11:15 - 12:00	0.031	"
		Gallaher Bridge	10:00 - 11:00	0.007	"
		Gallaher Bridge	11:00 - 12:00	0.000	"
		Gallaher Bridge	12:00 - 1:00	0.000	"
		Chestnut Ridge	10:30 - 11:00	0.000	"
		(≈1/2 mile East)	1:30 - 1:36	0.000	"
		Bear Creek & R.R. Road	10:58 - 11:08	0.038	Hi-Vol
10/5/65	55#UF$_6$ 5" cyl. 11:05 a.m.	Test Site	9:00 - 10:00	0.010	CAM
		Test Site	10:00 - 11:00	0.000	"
		Test Site	11:00 - 11:45	0.012	"
		Test Site	9:37 - 9:47	0.054	Hi-Vol
		Test Site	11:10 - 11:25	0.066	"
		Gallaher Bridge	10:00 - 11:00	0.003	CAM
		Gallaher Bridge	11:00 - 12:00	0.013	"
		Gallaher Bridge	12:00 - 1:00	0.007	"
		Chestnut Ridge (1/2 mile East)	9:30 - 10:30	0.010	"
10/7/65	250#UF$_6$ 8" cyl. ≈3:00 p.m.	Test Site	2:00 - 3:00	0.010	CAM
		Test Site	3;00 - 4:00	0.025	"
		Test Site	3:13 - 3:23	0.608	Hi-Vol
		Gallaher Bridge	1:00 - 2:00	0.005	CAM
		Gallaher Bridge	2:00 - 3:00	0.010	"
		Gallaher Bridge	3:00 - 4:00	0.005	"
		Bear Creek @ White Wing	3:14 - 3:24	0.118	Hi-Vol
		Wheat @ Turnpike	3:29 - 3:39	0.100	"

*MPC$_a$ - Continuous exposure General Population
- 0.04 uranium alpha c/m/ft^3.

UF_6 Cylinder Fire Tests
Airborne Alpha Activity

Date	Test	Sample Location	Sample Period	U Alpha c/m/ft^3	
10/14/65	55# UF_6	Test Site	10:00 - 11:00	0.007	CAM
	≈11:25 a.m.	Test Site	11:00 - 12:00	0.023	CAM
		Test Site	12:00 - 1:00	0.023	"
		Test Site	1:00 - 2:00	0.013	"
		Test Site	10:50 - 11:00	0.050	Hi-Vol
		Test Site	11:30 - 11:40	0.094	"
		Gallaher Bridge	10:00 - 11:00	0.024	CAM
		Gallaher Bridge	11:00 - 12:00	0.018	"
		Gallaher Bridge	12:00 - 1:00	0.018	"
		Chestnut Ridge	10:00 - 11:00	0.017	"
		(≈1/2 mile East)	11:00 - 12:00	0.010	"
		"	12:00 - 1:00	0.010	"
		Pine Ridge	11:00 - 11:10	0.143	Hi-Vol
		(≈1/2 mile West)	11:30 - 11:40	0.085	"
10/29/65	250# UF_6	Test Site	12:00 - 1:00	0.000	CAM
	8 in. cyl	Test Site	1:00 - 2:00	0.011	"
	≈2:05 p.m.	Test Site	2:00 - 3:00	0.010	"
		Gallaher Bridge	1:00 - 2:00	0.000	"
		Gallaher Bridge	2:00 - 3:00	0.000	"
		" "	3:00 - 4:00	0.000	"
		Chestnut Ridge	1:00 - 2:00	0.000	"
		(≈1/2 mile East)	2:00 - 3:00	0.010	"
		"	3:00 - 4:00	0.013	"
		Chestnut Ridge (≈ 2 miles East)	2:10 - 2:20	0.001	Hi-Vol

*MPC_a - Continuous Exposure General Population - 0.04 uranium alpha c/m/ft^3.
CAM - Continuous air monitor
*Portable units (short-term air sampler)